London to gravity at the equator would eventually be known, and meanwhile a base of connection was wanted. It is perfectly true, as I have already said, that an absolute determinination is eminently satisfactory, and (theoretically) can stand by itself; but practically they rarely did so. It is perfectly true that if the length of a pendulum is actually measured and its rate observed, an independent determination is made; but practically the determination was almost always relative. The pendulum was generally not so much measured as to its actual length, whatever that might be, as adjusted to a certain length such as (very commonly) had been previously done at Paris or London. The distinction is very clear in some cases, less so in others. But, generally speaking, the determination has as good a right to be classed among the differential ones as among the absolute.

Consider the case of Graham's pendulum as used by Campbell at Jamaica. It was purposely designed to be adjusted *to the same length*. Or, again, consider Legentil's. He was constantly testing and adjusting the length by means of a *règle en fer*, and the only kind of measurement which took place was that of examining the equality from time to time of the length of his *pite* fibre.

It appears to me to be entirely beside the mark to insist that his *règle* or gauge had been compared or measured. It was used as a gauge and not as a measuring scale.

The same applies in nearly all cases. A gauge is always found to have been used, and some constant addition or subtraction made for the calculated position of the centre of oscillation.

That which gives to all the older determinations their apparently absolute character is that the result is *expressed* in linear measure. Considering the exceedingly doubtful character of the linear element so introduced, it is practically certain that the only chance of utilising any of these is to get back to the *observed rate* if possible, and to treat them all as merely differential.

Let it not be supposed that we shall lose anything by this. As things now stand, observations which were essentially differential and often good of their kind are under the cloud of doubtful reduction, caused by the endeavour to kill two birds with one stone. Experience has shown that this is barely possible even now, with vastly better means. Common sense suggests that it was vain before.

I have hitherto been speaking of the last century. The aspect changes somewhat as we enter the present one. Scarcely a trace remains of the absolute force of gravity as a real object. The idea of a linear standard is still active, but evidently doomed. What will be left as the *motive* for absolute determination, in preference to differential? I confess that I can give no answer. Anxious as I have been, and am, to learn and to understand the whole of this subject; careful as I may be to catch at every indication of an unexpressed idea latent in the mind; it is in vain that I try to find a *raison d'être* for absolute pendulum operations at the present day. It would be impossible to say this and not imply dissent from the views of those who advocate their prosecution, and I am well aware that such views *are* advocated by a section of the Continental geodesists. But I seem to be unable otherwise to find a solution. A year has elapsed since this paper was written—all but these two sentences—and I have learnt nothing to change my opinion. J. HERSCHEL

NOTE ON SOME EFFECTS PRODUCED BY THE IMMERSION OF STEEL AND IRON WIRES IN ACIDULATED WATER [1]

DURING a discussion upon a very interesting paper by our president, "On the Durability of some Iron Wire," I mentioned a fact which I had lately observed, viz., that steel or iron wires immersed for a few minutes in acidulated water containing one tenth sulphuric acid became excessively brittle. Our president has since kindly asked me to make a few more experiments on this subject, and to embody them in the form of the present note.

Upon repetition of these experiments I have found that this brittleness is no mere accidental result, due to some flaw in the steel or iron wires, but that the resulting brittleness is invariable in all kinds of steel as well as iron. Nor is the effect due to any specific proportions of sulphuric acid to the water; nor, in fact, as we shall see later, to any particular acid. The effects, however, seem confined to steel and iron; as by similar treatment I have as yet obtained no perceptible effect on copper or brass. At first I was inclined to believe that the effects were due primarily to a change in the molecular structure; but a more extended series of experiments has led me to adopt entirely the view taken by my friend Mr. W. Chandler Roberts, who predicted that the effects were most probably due to the absorption of hydrogen.

I have tested these wires in my induction balance, but can find no change whatever in its magnetic conductivity, nor any change which would be the equivalent of those produced by heat, strain, torsion, or tempering; but there are very evident results produced: if the conditions of the experiments are such as to favour the absorption of hydrogen. For instance, if we reduce the proportion of sulphuric acid to one-twentieth, we find that it requires some thirty minutes' immersion to produce the full effect, a few minutes' immersion producing no perceptible result. If now we place an amalgamated zinc plate in the same liquid, and join the two extremities, we have an ordinary battery, where hydrogen is given off on the steel wire. Now as the hydrogen produced by the decomposition of the water is much more rapid than before, we find that a few minutes' immersion produces a far more brittle wire than could be obtained by hours of simple immersion, and we have the result free from any doubt as to its being a mere surface action; for if we immerse the wire alone, surface corrosion rapidly takes place, but by simply connecting it with the zinc the steel is perfectly protected, retaining its original bright surface, for any time, as long as it is so protected.

It is not absolutely necessary that we should join the zinc in the same cell, for if we pass a current from a few cells of an external battery through two steel wires as electrodes in sulphuric acid and water we find that both wires have become brittle, though in a very different degree, the wire connected with the zinc or negative pole remaining bright, although excessively brittle, whilst the one connected with the positive pole is much corroded, and but feebly brittle, with this arrangement. I find that sulphuric acid is no longer required, but that all acids, neutral salts, and ordinary water produce an active effect, the time required being simply as the conductivity of the liquids employed. When water or most neutral salts are used, we find the negative pole quite bright, but brittle, the positive pole much corroded, but not at all changed as regards its flexibility.

I believe that these effects are due to the absorption of hydrogen when the hydrogen is in the "nascent" state, for I have obtained no results by continued immersion in carburetted hydrogen gas (ordinary lighting gas), but when plunged into a medium containing the hydrogen just freed from its combination, its effects are most remarkable: for if we immerse a wire into sulphuric acid and water, say one-twentieth, the effects are slow, requiring at least thirty minutes; but if we let fall into this water some scraps of zinc hydrogen is rapidly given out, and by now immersing the steel wire in this gaseous liquid, taking care not to touch the zinc, we find that the steel becomes rapidly brittle, whilst its surface is free from corrosion, due no doubt to the protecting surface of surrounding hydrogen.

Hydrogen seems to permeate through the entire mass, for iron rods a quarter of an inch thick were equally affected, requiring more time, or in other words, a supply of nascent hydrogen sufficient for the larger mass; and once the wire has become hydrogenised (if we may be allowed the expression), it retains it under all circumstances of time and change of surrounding atmosphere: heat alone, of all the means I have tried, has any effect; and if we heat a wire to cherry red in a spirit lamp we find that it is completely restored to its primitive flexibility in a few seconds. This same wire, however, on being immersed in the accidulated water, rapidly becomes again brittle; we may thus at will render the same wire flexible by previously heating it, or render it exceedingly brittle by favouring its absorption of hydrogen.

I have remarked that a wire immersed in sulphuric acid and water of any proportion, say one-sixteenth, becomes more electro-negative than at the first instant of plunging. If we take amalgamated zinc as the positive element, and a steel or iron rod or wire for negative, we find that there is such a remarkable similarity of electromotive force between all kinds of steel and iron that we are forced to the conclusion that we are simply testing the electro-negative qualities of hydrogenised iron; the force being with amalgamated zinc ·56.

I noted here a remarkable fact, and which does not agree with the results of many authorities. I found that as soon as the

[1] Read before the Society of Telegraph Engineers, April 14, by Prof. D. E. Hughes.

iron rod had absorbed its maximum of hydrogen (a few minutes after being short-circuited), it became a constant cell, giving but small traces of polarisation when or after being short-circuited for hours at a time. There occurs, however, a slight diminution of electromotive force after a few days' hard work, being then ·52, due to the acidulated water becoming more neutral by the formation of sulphate of zinc and iron. If, however, we wish to restore its full electromotive force, we have only to short-circuit the cell for a few seconds, torrents of hydrogen will be given off, and its electromotive force becomes, on testing of its highest value, ·56.

If we short-circuit the hydrogenised iron cell for one minute, and at once test its electromotive force, we shall find at the first instant a certain amount of polarisation, about 10 per cent., but it rapidly recovers, being at its full initial force in ten seconds' repose; whilst carbon, platinum, and all other negatives yet tried, did not recover their polarisation in several minutes' repose.

Taking the Smee battery as the best example of depolarisation in a single liquid, and comparing the constancy of this cell with that of the hydrogenised iron, I find that according to Mr. Latimer Clark's experiments, in his work on electrical measurements, that the electromotive force of a Smee cell is 1·017, but when in action only ·446. Thus its electromotive force in action is less than that of the iron cell, and its polarisation some five times greater than that of iron.

I have submitted these results (rather hastily obtained) to our president, Mr. W. H. Preece, and he has kindly consented to have some exact measurements made of the electromotive force of hydrogenised iron, and its comparative freedom from polarisation with all other metals employed as negative elements in a single liquid cell, the results of which quite agree with those obtained by myself.

A practical application of iron as a negative may be mentioned. If we wish to purify mercury from any zinc, or any metal less negative than iron, we have only to place the mercury in dilute sulphuric acid, and then introduce an iron rod so that its lower portion shall make contact with the mercury, hydrogen is now freely and constantly given off by the iron, and this continues until all traces of zinc have disappeared; and as a proof of this, if after a certain time, when no hydrogen is given off, we simply touch the mercury with zinc for an instant, the hydrogen at once reappears, and continues until this small portion of dissolved zinc has been separated from the mercury.

In order to render evident the remarkable depolarising power of iron, we use in the same cell several negatives, such as carbon, platinum, silver, copper, and iron; and if we test these negatives separately for its initial electromotive force, we shall find them all superior to iron. But if we join all the negatives together, and short-circuit the whole with the zinc, iron alone will freely give off its hydrogen, whilst carbon will appear to be entirely inert, and if after this short-circuiting we insultate or separate the different negatives, we shall find on testing them that they are all polarised, carbon being the most so, and iron comparatively quite free, and at its initial giving the highest electromotive force.

In conclusion I may add, that if hydrogen seems to be an enemy of iron and steel, rendering it brittle, on the other hand it is perhaps its best friend in rendering it more negative, and whilst under its entire influence completely preserving it from oxidation or rust.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The debated question of a Natural Science Degree will again come before Congregation on April 27. It is proposed to create a new faculty and to allow students in the Science Faculty to pass a modified form of Responsions and Moderations, in which a modern language may be substituted for Greek, but in which the mathematics required will be more advanced than at present. The following is the proposed form of statute:—

"*Of the Faculty of Natural Science.*—1. There shall be a Faculty of Natural Science, in which two degrees shall be granted, viz., the Degree of Bachelor of Natural Science and the Degree of Master of Natural Science.

"2. Any person duly matriculated wishing to proceed to a Degree in Natural Science shall be deemed to be a Scholar in the Faculty of Natural Science as well as in the Faculty of Arts."

In the Natural Science "Responsions" candidates shall offer two books, either (1) one Greek and one Latin, or (2) one Greek and one German, or (3) one Greek and one French, or (4) one Latin and one German, or (5) one Latin and one French. A special knowledge of the grammar of the languages of the books selected will be required. The candidates will also be examined in arithmetic, in plane geometry, including doctrine of similar triangles, and in algebra, including quadratics and ratio and variation.

In the Natural Science "Moderations" candidates shall offer *three* books, one being some portion of a Greek or Latin historical or philosophical work. The mathematical part of the examination will include theory and use of logarithms, trigonometry as far as the solution of plane triangles, the rudiments of plane co-ordinate geometry, and the mechanics of solid and fluid bodies treated by elementary methods.

After passing "Moderations" the student will be at liberty to enter the Natural Science School or the Mathematical School in honours.

A GRANT of 75*l.* has been made from the Worts Travelling Scholars' fund to Mr. J. E. Marr, B.A., of St. John's College, Cambridge, to enable him to travel in Norway, Sweden, and the islands of the Baltic, and collect evidence and specimens bearing upon the classification of the Cambrian and Silurian rocks, with the understanding that specimens be sent by him to the University, accompanied by reports which may hereafter be published.

THE Queen has signed the charter of the new Royal Irish University, the successor of the Queen's University. The Senate is large and fairly representative.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, April 15.—The Rev. G. Henslow in the chair.—The Secretary read a paper for the Rev. R. Boog Watson, on the Mollusca of the *Challenger* Expedition (Part 5). Some thirty-five species are described and compared, whereof the greater part are new forms and belonging to the families Solenoconchia, Trochida, Rissœllidæ, Litorinida, and Cerithiidæ. The author observes that temperature even more than mere depth seems an important condition in molluscan life, while both prove barriers to distribution, though great length of time naturally helps escape from these barriers. Where barriers of depth and temperature do not check distribution there is no limit to universality of distribution, and such is the case with certain existing species; still there is no trace of especial, lasting, and progressive change.—A communication was read by Mr. N. E. Brown on some new Aroideæ, with observations on other known forms (Part 1). Of the former the specimens are contained in the Kew Herbarium, and the latter are annotations, chiefly supplementary to Prof. Engler's recent monograph of the order. While following Engler, the author has given preference to the classification of Schott. Among others several interesting new Bornean forms are described.—Prof. F. Jeffrey Bell next read a note on an abnormal (quadriradiate) specimen of *Amblypneustes formosus*, and afterwards Mr. Chas. Stewart exhibited and made remarks on another but differently abnormal specimen of the same species.—Prof. Bell, after a full description of his specimen, observes: that with more or less reason some naturalists have looked on the possession of other than five rays as a character of some specific value among the Asteridæ and Ophiurida, and have considered that, on account of its greater rarity among the latter, it is of greater value as a mark of distinction; but such a view must be taken with considerable limitation. The pentamerous arrangement of parts in the regular Echinida is, then, only disturbed in one example; information and specimens are, however, at hand to show how this may have happened. The rarity of any divergence from this five-part division, in face of the numerous variations which occur in the Echinodermata, will doubtless become more and more important as a factor in determining the genealogical history of the group.—A series of microscopic sections of pearls exhibiting many irregularities in structural detail were shown by Dr. J. Murie, and their several peculiarities explained.—Messrs. S. H. Wintle and George Bay (of Tasmania) were elected Fellows of the Society.

Chemical Society, April 1.—H. E. Roscoe, president, in the chair.—The following papers were read:—On betorcinol and some of its derivatives, by J. Stenhouse and C. E. Groves. The authors have extracted from *Usnea barbata* an acid provisionally named barbatic acid, which is probably dimethyl-